

Western Australian geology: an historical review to the year 1870

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Abstract

The elucidation of the geology of Western Australia, prior to 1870, was often of secondary importance to those making the discoveries; however, the tangible results of these pioneers formed the basis of later investigations of the nineteenth century. The maritime surveys of the Dutch, French and English observed, in detail, the nature of bottom sediments, where soundings were taken, and the geology of the coasts where contacted. With the establishment of the Swan River Colony and the slow expansion of European settlement expeditions of discovery returned to Perth with detailed observations of the country traversed. The combined efforts of the Gregory brothers in addition to the treks of the German geologist von Sommer, added significantly to the previously poor knowledge of the geology of the interior of Western Australia. With the departure of the Gregorys and von Sommer from the colony, interest in the geology of the vast territory lapsed until the appointment of H. Y. L. Brown as Government Geologist in 1870.

Introduction

Just over 150 years ago, on 2 May 1829, Captain Charles Fremantle of H.M.S. *Challenger* landed at the mouth of the Swan River, and took formal possession of "all that part of New Holland which is not included within the territory of New South Wales". In 1 June 1829 Captain James Stirling arrived in the transport vessel *Parmelia* to take charge of the new Swan River Colony which was officially proclaimed on 18 June 1828. Stirling had previously examined the Swan River region in 1827 and reported favourably on it.

As the colony struggled for existence and then slowly prospered the demand for additional arable and grazing land increased along with the need for exploitable mineral deposits. This paper is an attempt to review the early observations on the geology of the colony and to document those who made the observations up to the appointment of Henry Yorke Lyell Brown as Government Geologist in 1870.

The history of official government appointees to investigate the geology of the colony (and later, State within the Commonwealth of Australia) has been well outlined in a series of historical reviews (Woodward 1890a, Maitland 1910, 1919 and Connolly 1976). A broader review of the development of the geological sciences in Western Australia, which includes previously unpublished information about the geologist Ferdinand von Sommer has recently been published (Lord 1979). The history of European settlement in Western Australia has been summarised by Bolton and Hutchinson (1973) in an article providing background information

against which the early history of geological explorations can be viewed. My review is based on published information—a full bibliography being attached. Further relevant information for the period undoubtedly exists in print, as the sources are very diffuse, and I shall be grateful for any literature omitted from the present survey.

Two valuable bibliographies include many of the sources mentioned—Etheridge and Jack (1881) and Maitland (1898). In addition three recent articles have considerable relevance to this review. The comprehensive survey by Vallance (1975) on the origins of Australian geology places many of the early observers of Australian geology in their historical context especially with regard to the philosophical arguments within geology in Europe during the early nineteenth century. The review of the history of the geological sciences in Australia by Branagan and Townley (1976) provides a useful survey of the geological investigations being undertaken in the other Australian colonies during the period under consideration in the present survey. Darragh's (1977) investigation into the origins of the earliest geological maps of the Australian continent is valuable in drawing attention to the remarkable work of Jukes (1850) hence posing the question as to the source of Jukes' information on Western Australia.

The history of geological investigations in Western Australia for the first 40 years of the colony reveals an initial period of preliminary discovery (1829-1840) followed by an extended period of expansion of activity (1841-1861), embracing two main peaks of investigation (the late 1840s and the late 1850s), in turn followed by a period of limited geological exploration (1862-1870).

The period prior to settlement

Isolated observations on the geology of the areas of the coast of Western Australia had been made prior to the establishment of the Swan River Settlement, with several collections of rock specimens being returned to Europe for examination. The earliest European observations on the coast of Western Australia verified by written records are contained in the early accounts of the Dutch and although invariably overlooked their journals occasionally contain information of geological interest. Fortunately these journals have been compiled into a comprehensive volume by Heeres (1899). As can be seen from the map produced by Isaac de Graaff (reproduced in Heeres 1899 opposite p.87) compiled after the voyage of Willem de Vlamingh in the years 1696-97, most of the western coast of Australia from the "Swaene-Revier" to the Golf van Carpentaria" (constituting the region of "Hollandia Nova") was known, while the southern coast of what is now Western Australia was known by 1630 (map in Heeres 1899, opposite p. 10). The early accounts portrayed the classic inhospitable land; for example the journal of Jan Carstensz (1623; Heeres 1899, p.22-44) contains such comments as "... a barren and arid land . . . natives are in general utter barbarians . . . they are utterly unacquainted with gold, silver, tin, iron, lead or copper". Observations of geological interest in this and other journals are few; however, they include notes on the nature of bottom sediments where soundings were taken and the colour of water flowing from the mouths of rivers.

The occurrence of the coastal dune calcarenites ("coastal limestone") of Western Australia occupied much of the interest of the early English and French voyagers such as Vancouver, Baudin and Flinders as has been reviewed by Vallance (1975, p.25-27). The French especially wrote at length on the distribution of this rock, in particular the journals of Peron (1807, p.110), Peron and Freycinet (1816, p.131) and Freycinet (1828, p.470). The accounts of these expeditions were the source of the information in the article by "a gentleman in the service of the Hon. East India Coy" (Anonymous 1830c) on the physical character of Peron Peninsula and Shark Bay. The article contains scattered references to the "calcareous and shelly sandstone". Von Buch (1814), when in Paris in 1810, examined the collection made by the Baudin expedition (1803-04) and made notes on the yellow sandy limestone from Seal Bay and Dirk Hartog Island (containing *Strombites* and *Patella*), the limestone from the Swan River and the granitic rocks from near King George Sound.

The French expedition of the *Astrolabe* in 1826-1829 sheltered in King George Sound during October 1826 and made extensive observations on the region. (D'Urville 1830 p.88-115). As a result of this French "intrusion" close to New South Wales the then Governor of that colony despatched Major E. Lockyer in charge of a small company from Sydney to found a garrison settlement. Lockyer established an outpost at Albany annexing the surrounding territory on 21 January 1827.

The earlier English maritime surveys of the coasts of Australia by P. P. King during the years 1818-1822 have left a legacy of journals rich in observations (King 1827). King made many observations

on the "coastal limestones" of King George Sound and considered they were composed of "merely sand agglutinated by calcareous matter" rather than coral (the earlier suggestion of Vancouver 1798, Vol. 1, p.49) or petrified vegetable matter (King 1827, Vol. 1, pp.12-13). King returned to King George Sound and made general observations in the granite of the area (Vol. 2, pp.152-153). Later (Vol. 2, p.185) the unusual rocks of Dirk Hartog Island attracted his attention; he noted that they consisted of "a congeries of quartzose sand, united in small circular kernels by a calcareous cement, in which some shells were found imbedded." The most significant geological contribution of King's journals is contained in the appendix describing his collection of rocks by W. H. Fitton (King 1827, Vol. 2 pp.556-629; also published separately, Fitton 1826). Points of interest in Fitton's account range from general observations on the hills near Port Keats being flat topped and hence having "very much the aspect of the summits in the coal formation" to warnings on the dangers of lithological correlation "since it appears that the accretion of calcareous matter is continually going on at the present time, and has probably taken place at all times, the stone thus formed, independent of the organised bodies, which it envelopes will afford no criterion of its date," (King 1827, Vol. 2, p.592, Fitton 1826, p.30). Fitton ascribed the occurrence of the "coastal limestone" above sea level to upheavals and earthquakes, continuing the tradition of relating its occurrence to some type of catastrophe (see Vallance 1975, pp.25-27 for a full discussion). Fitton concluded his remarks with "Instructions for collecting geological specimens" which are still as relevant today as when they were written.

The period of preliminary discoveries 1829-1840

After settlement, many brief geological observations were made in the immediate district surrounding the new towns. Brief geological observations made by M. Frazer, the botanist who accompanied James Stirling on his 1827 expedition to the Swan River, were published the same year as settlement (Anonymous 1829, 1830a, b.) These observations were general remarks on the soils and lithologies present. The early observations of Stirling, from the first months of settlement are given by Barrow (1831). Barrow's account illustrates the preoccupation of the colonists with agricultural and pastoral advancement, containing as it does extensive observations on the soils of the region; nevertheless the delineation of "primitive" areas of granite from more recent calcareous areas was becoming apparent. The collection of journals edited by J. Cross (1833) brings together the many observations of various short expeditions in the south-west of the new colony. These expeditions, which were led by army officers and settlers, contain occasional observations on the state of the land, soils and distributions of rock (i.e. sandstone, ironstone or limestone), however geological observations were of secondary importance in the quest for good land and water. As noted by Quilty (1975, p.69) A. Collie (in Cross 1833, p.174) mentioned that a bend on the Kalgan River "presented the indubitable impressions of shells and other organic remains". The general account of the colony by William Milligan (1837) contains brief geological notes drawn from earlier accounts including that of the Venerable Archdeacon T. H. Scott

(1831) who was "accidentally detained for several months at the settlement". Scott's observations concerned the development of the "coastal limestone" with numerous concretions "having the appearance of inclosing vegetable matter" (Scott p.320); and a brief account of the higher Darling Range to the east, composed "of greenstone and sienite".

The *Beagle* under Captain Robert Fitzroy, called at King George Sound in 1836 on her voyage home and Charles Darwin accompanied Fitzroy on a short excursion to Bald Head. Darwin noted (1839, p.537) that "according to our view, the rock was formed by the wind heaping up calcareous sand, during which process, branches and roots of trees and land shells were enclosed; the mass being afterwards consolidated by the percolation of rain water". Darwin was not impressed with the landscape—"he who thinks with me, will never wish to walk again in so uninviting a country"—or for that matter with Australia as shown by his now famous remark "Farewell Australia! you are a rising infant and doubtless some day will reign a great princess in the south: but you are too great and ambitious for affection, yet not great enough for respect. I leave your shores without sorrow or regret".

The state of the geological knowledge of the Swan River Colony by the end of the 1830s was summarised by Sir James Stirling (1838, p.5). His report was clearly the source of the geological notes on the Swan River Colony given by Nathaniel Ogle (1839, p.24) in his manual for emigrants to the colony of Western Australia. Stirling's report is the first succinct synthesis of the scattered geological observations of Western Australia. His summary, not readily available, is quoted in full: one can note that in 1838 it took two paragraphs to summarise all the geological knowledge of the colony!

"The whole of the occupied portion of the territory appears to rest upon a granitic base; rocks of that description having been found to exist in every district which has been as yet explored. In the neighbourhood of Doubtful Island Bay the granite assumes the stratified form of gneiss, and as red sandstone is found on the north-west coast, and tertiary formations on the shore of the Australian Bight, it is probable that the general dip of the country is in a direction a little to the north of east. To the south of the 31st degree of latitude there are no mountain ranges of any great altitude; the highest as yet known being that of Koikyeunreuff, near King George's Sound which attains to the height of 3,500 feet. On the primitive base of the country, none of the secondary formations have been found to exist; basaltic rocks are not however unfrequent in almost every district in the country; and in one position in Geographic Bay, there is a columnar formation, resembling in its character that which exists on the north coast of Ireland. The principal range of hills extends in a northerly direction from the south coast, near Cape Chatham, for at least 300 miles. The only varieties of rock which have been found on this granite range, are occasional portions of roofing slate, and of indurated clay; but extending from the western base of these hills towards the sea, upon an average breadth of about 20 miles, there is a low and tolerably level plain of diluvial origin, which bears the marks of having been covered by the sea at some remote period. The portion of this plain

nearest to the sea presents limestone hills, which have a slight covering of meagre sandy soil; the remainder varies from sand to clay, with exception of the lands in the immediate vicinity of rivers, which have been affected, and rendered rich, by the overflowing of the streams."

"The mineral substances heretofore discovered, are lime, marl, selenite, slate, siliceous and calcareous petrifications, magnetic iron ore, peacock iron ore, chromate of lead, and chrystals of quartz. The very small portion of the territory which has been inspected being almost entirely of a primitive description, a larger list of minerals could not be expected; but when time shall permit the further examination of the northern districts, of the red sandstone formation, it is not unlikely that important mineralogical discoveries may be effected. The discovery of copper ore by Captain King in the vicinity of Camden Bay corroborates this expectation" (Stirling 1838, p.5).

The year 1838 saw the discovery by J. A. L. Preiss of a fossil which Moore (1884, p.376) thought was an "encrinite" and therefore might indicate the presence of "transition or secondary formation" and hence the possibility of coal being found. The reward of 1036 hectares of land to the discoverer of an economic deposit of coal was initiated by the Governor.

The years 1837-39 saw the expeditions of George Grey, his journals (Grey 1841) containing much of geological interest. His account of the northern expedition from Hannover Bay includes notes in which he clearly recognised the volcanic nature of the rocks (Vol. 1, pp.162-163, 168). Some he compared with the vitrified lava of Ascension; others were referred to as basalts. It would appear he regarded the volcanic rocks to be of fairly recent origin (judged from the topography) rather than the Middle Proterozoic Age now ascribed to them (Geol. Surv. W.A., 1975). However he noted the paradox of bedded sandstones (compared with the Old Red Sandstone) resting on basalt at a watershed of the Prince Regent River (Vol. 1, p.192). Vallance (1975, pp.27-28) discusses at length the arguments, raging in Europe in the 1830s and 1840s on the origins of valleys. One can note that Grey was apparently a fluvialist, or at least he was certainly well aware of the erosive powers of running water. On his northern expedition he noted (Vol. 1, p.97) the occurrence of lofty sandstone pillars and "as the tops of all of them were nearly all the same level, that of the surrounding country must at one period have been as high as their present summits—probably much higher". He noted on every side "the same extensive degradation" accompanied by small streams gurgling through caverns "which in the rainy season must become a perfect torrent". He observed the same streams in the rainy season (Vol. 1, p.98). Later, on his remarkable trek to Perth from the wreck of his vessel, he noted the deep gorges of several of the rivers crossed making the equivocal observation that "the ravines, now traversed by water courses or streams, apparently much too insignificant to have grooved them out", (Vol. 2, p.26).

It has occasionally been noted in reviews of Western Australian geology (c.g. Maitland 1900, p.13; Teichert 1941, p.374) that Grey was apparently the first to observe Carboniferous (i.e. Permian) rocks in Western Australia; however, this is apparently

not the case. Although he speaks of limestone in the regions of the rivers and considered that the valleys "partook exactly of the character of those in the Carboniferous limestone districts of England" (Vol. 2, p.26) an examination of his map (Vol. 1.) indicates he was too far to the west to have traversed Permian rocks.

To complete the period 1829-1840 mention must be made of the second volume on geology resulting from Dumont D'Urville's 1837-1840 Voyage au Pole Sud. Although appearing in 1854, the summary of the geology of the western half of the continent only includes information gathered up to 1840 (Grange 1854, pp.77-78).

The period of expansion 1841-1861

By 1841 the exhaustive survey of the coasts of Australia by HMS *Beagle* was under way and the journals of Commander J. L. Stokes contain many geological observations, usually restricted to the occurrence of a particular lithology, made during the course of the voyage. Observations on the cliffs of Hannover Bay (Stokes 1846, Vol. 1, p.107-108) reveal an unusual streak of catastrophism—the cliffs "which rise from 70' to 90' in height, their bases apparently resting amid huge and irregular masses of the same white sandstone as that which forms the cliffs themselves, and from which this massive debris, strewn in all conceivable irregularity and confusion around, appears to have been violently separated by some great internal convulsion". Further to the north-east near Port Keats he found "a few fossils" and named Fossil Head (Vol. 2, p.32-33). As noted by Jukes (1850, p.72) these fossils were subsequently either lost or destroyed; however Stokes in a letter to Jukes (1850, p.72) described them as "casts of shells, not of a recent appearance". Jukes goes on to make what is little more than a remarkable guess (p.73) that they were probably the same age as the "Palaeozoic Formation which is found so largely in New South Wales" (i.e. Permian in modern terms).

While the *Beagle* was charting the shores of Australia, Edward John Eyre was carrying out the heroic trek of crossing the continent from Adelaide to King George Sound (1840-1841). The principal task of his arduous trip, as recorded in his journals (Eyre 1845), was to stay alive; nevertheless, his journals contain geological remarks. His route followed the coast (Fig. 1) and he recorded the change from the Tertiary limestones of the Nullarbor Plain (his "fossil formation") to the granite terrain of King George Sound.

A full description of the ancient sea cliffs, near the present township of Eucla, is given (Vol. 1, p.338-339): "The brown or upper portion consisted of an exceedingly hard, coarse grey limestone, among which some few shells were embedded, but which, from the hard nature of the rock, I could not break out; the lower or white part consisted of a gritty chalk, full of broken shells and marine productions . . . parts of it exactly resembled the formation that I had found up to the north, among the fragments of table land; the chalk . . . was traversed horizontally by strata of flint ranging in depth from six to eighteen inches, and having varying thicknesses of chalk". As a result of his journey and using a variety of observations, including geological, Eyre

(1846) argued strongly against the existence of the inland sea of Australia. For his remarkable efforts in exploration Eyre was awarded the Founders Medal of the Royal Geographical Society of London (Hamilton 1843).

The Swan River Colony was now becoming interested in other means of increasing exports. One such method was through the discovery of raw materials. The discovery and testing of a small deposit of iron ore near the Swan River by J. W. Gregory (1843) suggested the possibility of the discovery of coal in the vicinity (additional remarks to Gregory's paper by J. Harris). The search for coal dominated much of the geological exploration for the new few years in the colony.

The spark was supplied in 1846 on 9 September when "two seams of coal were discovered one about 5 and the other 6 feet in thickness with several beds of shale and sandstone" in the valley of the Irwin River by three of the Gregory brothers (A. C., F. T., and H. C. Gregory—see A. C. Gregory 1848). Contemporary independent comment on the Gregorys' discovery and Western Australian geology in general is offered by Rosendo Salvado (1851, p.64-66 in a much neglected volume published in Rome and now available translated into English by Stormon (1977)).

The Acting Governor of Western Australia F. C. Irwin responded immediately to the discovery of coal by despatching on 2 December 1846 "the colonial schooner "Champion" with a party under the direction of the Surveyor-General, accompanied by Dr. von Sommer, the geologist . . . to Champion Bay, with instructions to examine the country". (Irwin 1847, p.187). Strangely Lieut. Benjamin Francis Helpman's account of the Survey contains no mention of von Sommer, although mention is made of both A. C. and J. W. Gregory. Helpman (Commander of the schooner) and party were back at the Irwin River by 12 December 1846 and noticed "the coal fire made by Messrs. Gregory had left nothing but very fine ashes and no cinders" (Helpman 1848, p.40). Readers of these contemporary journals should be aware of the confusion between the names applied by Grey (1841) and others to rivers in the region; the note and map by Arrow-smith (1848) explain the discrepancies.

Von Sommer's own accounts are enigmatic. Part of his report is condensed and given in Irwin (1848, p.240) which also includes further instructions to von Sommer to explore the south-west of the colony for coal and minerals. Von Sommer's own published accounts of his explorations reveal a wealth of observations on the geomorphology and soils of the country he traversed. Geological observations are succinct and typically contain correlations based on lithology. Von Sommer includes many observations on the Irwin River area mentioning seams up to "five feet thick". Deductions from dip and strike measurements were made as to where further coal might be found to outcrop (von Sommer 1848b, 1849a). Contemporary press reports by "a gentleman holding a high official appointment in the western province" indicate a rather exaggerated translation of von Sommer's thoughts, with seams of coal "up to 12' thick" and "one of the greatest coal fields in the world". One can certainly question the accuracy of the press of that time.

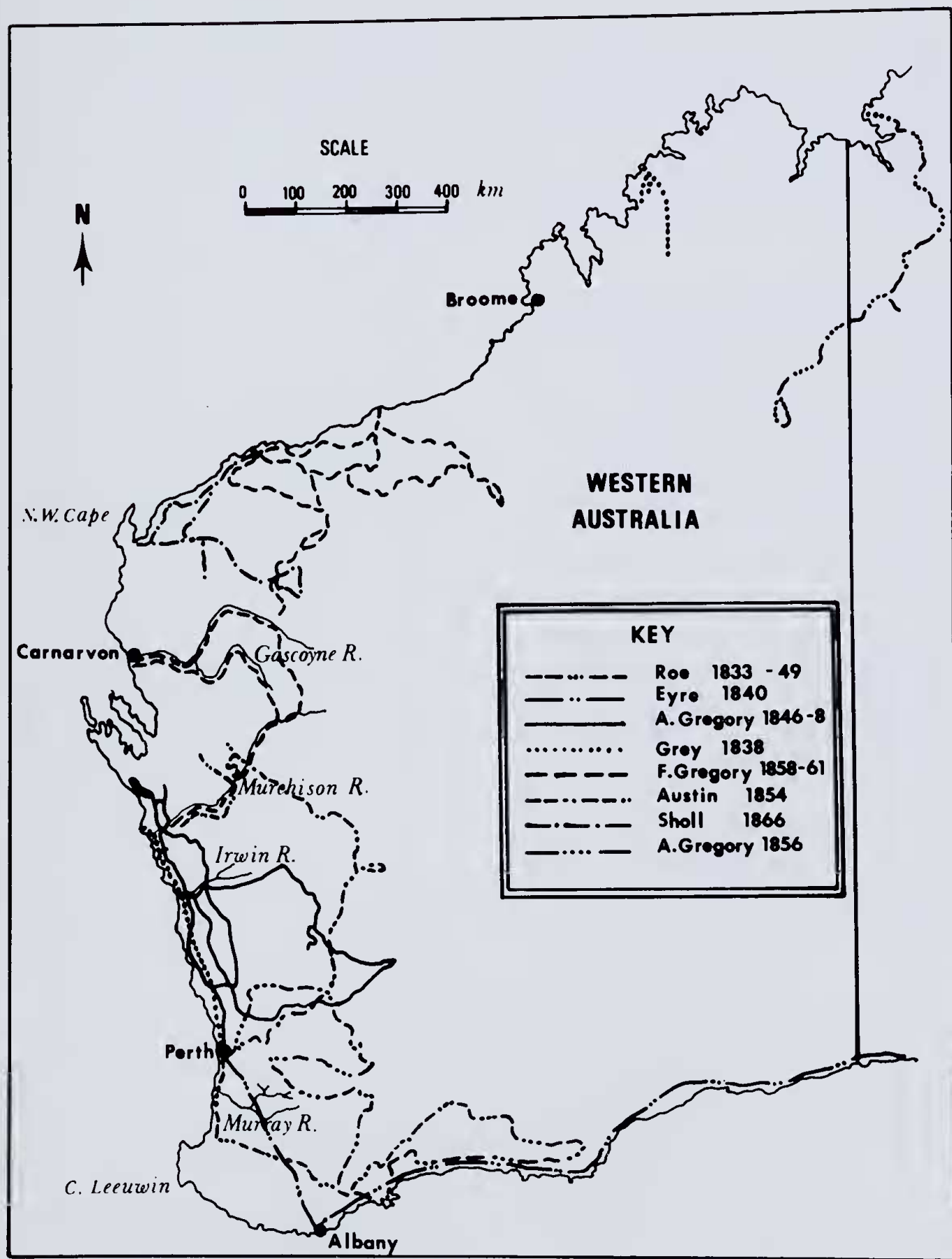


Figure 1.—Map of explorers' routes 1833-1866.

In von Sommer's brief survey of the geology of Western Australia (1849b) several observations on the Irwin River district appear, including dip measurements and a stratigraphic column with the thickness of coal stated to be 1.6 m. (For convenience the press reports are listed in the bibliography as von Sommer 1847 and 1848a—the second being a direct copy of the first). Von Sommer's catalogue of specimens from New Holland (1849c) is noteworthy for its rock classification (including the terms *Plutonisch*, *Neptunisch* and *Chemisch*) and also for its value in giving an indication of the specimens he collected.

After the 1846 expeditions of the Gregorys it appears that a geological map of the colony was produced and presented to the Geological Society of London by J. W. and F. T. Gregory. Regrettably the map and paper were never published although they were noted in the Proceedings of the Society in the form of an abstract (Gregory, J. W. and F. T. 1848). Fortunately J. W. Gregory's views of the geology of Western Australia were published in the colony (Gregory, J. W. 1849). His account reveals the substantial increase in knowledge of the lithology and mineralogy of the colony as well the areal extent and stratigraphic sequence of geological units. A deductive geological history is also provided. The young colony clearly lost a flourishing "amateur" geologist with J. W. Gregory's death in 1850.

A. C. Gregory was again sent north from Perth in August 1848, this time with C. F. Gregory, to examine the country as far north as the Gascoigne (sic) River (Gregory 1852a, p.57). Again he was asked to examine the Irwin River coal and its extent including "to the northward of it in the direction of Shark's Bay where Dr. von Sommer thought the coal seam of the Irwin might again make its appearance" (letter to A. C. Gregory from R. R. Madden, Colonial Secretary, 28 August 1848, quoted in Gregory 1852a, p.58). A few brief observations were made on the Irwin River coal. However, the 1848 expedition was notable for another reason; on 16 October 1848 abundant specimens of galena were discovered, in the bed of the Murchison River. Gregory observed that "the existence of garnets, iron pyrites and a mineral resembling in many of its properties plumbago, specimens of which were found in a gneiss of this district seems to indicate a metalliferous formation" (Gregory, A. C. 1849, p.75; 1852a, p.66).

The discovery of galena initiated a visit to the Murchison River by the Governor, Charles Fitzgerald in December 1848 (Gregory, A. C. 1849, p.78-80 and 1852b). Extensive observations were made on the galena vein and its host rock (Gregory 1852b, p.72), traces of copper being noticed. In a footnote to Gregory's account (1852b, p.73) entitled "extract from the narrative of a journey from York to Champion Bay in the colony of Western Australia . . . by Mrs. Brown of Grass Dale" brief notes are included on the operation of the Geraldine Mine. Connolly (1976, p.80) notes that the Geraldine Lead Mine was established in 1849 and that the first recorded export was of pig lead, to the value of \$2400, and a small quantity of copper in 1853.

The search for coal also extended south of the Swan River Colony. Reports of coal near the Murray River (Urban 1847) and in the vicinity of Cape Riche (Irwin 1848, p.240) were apparently false. Von Sommer, from his observations at the Irwin River, had considered that coal may occur east of King George Sound (Irwin 1848). As if in answer to his predictions the expedition of John Septimus Roe in 1848-49 announced the discovery of coal in the bed of the Fitzgerald River (Roe 1852, p.36) as well as "elongated globules of bitumen". Roe made many geological observations in his journals (1849, 1852) and his sketch map (accompanying the 1852 report) contains many annotations complementing the earlier observations of Eyre. Roe's discovery of coal was another false alarm although many years were to pass before the matter was finally settled. Dixon (1885, p.9), writing of his searches in 1867, found only lignite seams and considered the bituminous substance to have been washed in by the sea. Woodward (1890b, p.50-51) noted the presence of brown carbonaceous material occurring in a series of pockets or hollows resting on the upturned edges of altered slates. He again reiterated the existence of huge quantities of "mineral pitch" washed up on the beach along the southern coast of Australia. Cockbain and van de Graaff (1973) have recently reviewed in detail the history of the discovery and the occurrence of lignite in the Fitzgerald River.

One of the most skilled geological observers to visit the Swan River Colony was J. Beete Jukes naturalist of HMS *Fly* during the surveying voyage of 1842-46. Although brief comments on the geology of Western Australia are made in the various abstracts of his papers (Jukes 1847a,b,c; 1848a,b) it is in his major work (1850) which contains extensive observations and a synthesis of the geology of Western Australia. Jukes published with his book the first coloured geological map of Australia (Darragh 1977); a modest attempt with the colours "dabbed on roughly". His sources of information on the western portion of the continent were his own observations made on an excursion of "two or three weeks" (1850, p.60) and contemporary published journals. He added to the already large literature on the dune limestones observing: "I saw some of these dendritic masses fully exposed and from their peculiar structure and conformation, I believed them to be nothing more than stalactites formed in the sand by the percolation of rain water dissolving and taking up the carbonate of lime found in the sand, and redepositing it in fantastic forms wherever a pre-disposing cause happened to determine it". (p.61). He updated his observations with the London publications of A. C. Gregory, B. F. Helpman and F. von Sommer pointing out the discrepancies between the dip measurements of the Irwin River Coal of Gregory and von Sommer. He considered von Sommer's dip measurements to be more probable and then offers the enigmatic comment "but the remainder of his observations are little to be depended on" (Jukes 1850, p.66).

After the death of J. W. Gregory in 1850 and the departure from the colony of F. von Sommer in 1851 geological investigations decreased in extent. However, expeditions into the vast unexplored territory continued throughout the 1850s adding to the knowledge of the geology of the colony. In the late 1850s the impending International Exhibition in

London (1862) appears to have stimulated further investigations. The extent of the geological knowledge of Western Australia prior to this second wave of expeditions is well illustrated by Bonwick's 1855 text book on the geography of Australia and New Zealand. It contains (p.63-65) a brief summary of Western Australian geology including a note on the bituminous coal of the Murray River, apparently confusing that river with the Irwin.

The expedition of Robert Austin in 1854 (Austin 1856) expanded the explored areas of the colony eastward of the Irwin and Murchison rivers; the detailed published journal contains a map showing the route traversed with the position of each night's camp, and thus the positions of the rocks recorded each day can be noted with some accuracy.

The North Australian Expedition (1856-57) under the command of A. C. Gregory, although covering much of what is now the north-west of the Northern Territory, made a traverse into the far north-east of Western Australia (Fig. 1). Included in the party was a geologist, James S. Wilson, whose articles (Wilson 1857, 1858a, b) contain considerable information on the geology of northern Australia, the sandstones being correlated with the Sydney Basin sandstones. Regrettably, however, much of his discussion concerns regional generalisations rather than specific observations. Accounts of the preparatory stages of the expedition and brief accounts detailing the advancements of the expedition are contained in volumes 1 and 2 of the Proceedings of the Royal Geographical Society, London, in the form of letters of interested persons as well as progress reports (e.g. Baines 1858). One noteworthy item is contained in a letter from John Kent of Sydney to Dr. Shaw, Secretary of the Royal Geographical Society (Proc. Roy. Geog. Soc. 1: 10-11). Kent makes observations on the characters of several members of the expedition team. Of A. C. Gregory he states "... I deem him a most competent leader for such an expedition. Spare and active, quiet and reserved in manner, with great firmness of purpose, he is well adapted to conciliate the aborigines and, what is more essential, the elements comprising his own party. I think it would be difficult to find four men better adapted for undergoing fatigue than the brothers Gregory, Wilson and Baines. Of the others I cannot speak so confidently; but the patience and resignation of Dr. Müller have been tested by a seat for three days up a gum tree, waiting for the subsidence of a flood. He is a German botanical enthusiast which will account for this incident in his experience". Dr. Müller, was later Baron Sir Ferdinand von Mueller, Victorian Government Botanist. The progress reports of the North Australian expedition stimulated W. H. Fitton (1857) to again make several observations on the geology of northern Australia. He noted, from published accounts, the similarity between the rocks of the western side of the Gulf of Carpentaria with those in the north-west collected by P. P. King and included that they formed "a great natural division of the country". In actual fact Fitton made a generalised correlation of the Kimberley Basin rocks of north-west Australia with the McArthur Basin rocks of the Northern Territory. Fitton considered the rocks could be correlated with the Old Red Sandstone of Britain.

On his return to Victoria after the North Australian Expedition, F. von Mueller (1858) provided a brief history of exploration in Australia. This is of particular interest as it includes a short account of the physical geography of Western Australia by A. C. Gregory including two maps, one a geological diagram and one a botanical diagram. Although not coloured the geological map appears to be an original of Gregory's as it contains rather more information than Jukes' map of 1850. For his efforts in the exploration of Australia A. C. Gregory was awarded the Founder's Gold Medal of the Royal Geographical Society in 1856, (Murchison 1857).

The late 1850s saw Francis T. Gregory make expeditions to the Murchison, Gascoyne and Lyons rivers, adding greatly to the geological knowledge of the colony. The journals (1859) contain the details of the geological observations which were used to produce the geological map and paper of 1860 (F. T. Gregory 1860; 1861a,b,c). F. T. Gregory discovered the Permian (although he referred most strata to the Carboniferous) sequences outcropping in the region of the Lyons and Gascoyne rivers and indicated the presence of the Mesozoic rocks higher in the sequence. His paper has been taken as the starting point of Western Australian Upper Palaeozoic geology in the past (e.g. Teichert 1941). A collection of rocks and fossils and a copy of the map produced by J. Arrowsmith were presented to the Geological Society of London (Annual General Report of the Society for 1862 p. x-xi, and an appendix to Gregory's paper by T. R. Jones (editor of the Quarterly Journal of the Geological Society) included a short list of identifications of the fossils. It is worth noting that the organization of his paper follows closely the organization of his brother's paper published 13 years previously in the colony; as F. T. Gregory states his geological history "differs but slightly from some geological notes published in the colony some ten years ago by my late brother Mr. J. W. Gregory" (F. T. Gregory 1861a, p.482).

For his efforts in the exploration of Australia, F. T. Gregory was awarded the Founder's Gold Medal of the Royal Geographical Society in 1862 (Murchison 1863). Of his map, H. P. Woodward (1890a, p.5) noted "that no professional geologist would be ashamed to own it and indeed so accurate ... as I found in that portion I examined last year, that (his) mapping will be retained provisionally for those portions not yet re-examined".

Collections of rocks and fossils and the geological map were exhibited at the International Exhibition, London 1862, the catalogue of which (Andrews 1862) contains general lists as well as detailed notes on the various mines then active in the colony. On the basis of Gregory's collections and those of a Mr. Shenton of the colony sent to a Captain Sanford of Nynehead, Moore (1863) was able to confirm the presence of Mesozoic rocks in Western Australia—the collections being fully described by Moore some years later (Moore 1870).

The closing of the era of Gregory explorations in Western Australia occurred in 1861 with the expedition to north-western Australia. A detailed map of the route taken by the expedition was produced

(F. T. Gregory 1862a) and a lengthy account was published at the time (F. T. Gregory 1862b). Geological observations are numerous, usually restricted to observations of the lithologies occurring on the route. As noted by Darragh (1977, p. 299) a hand-coloured geological map, based on the observations in the journal, exists in the State Library of Victoria map collection. The colouring was apparently carried out by R. B. Smyth the then Victorian Secretary of Mines (see Darragh 1977 for full discussion of Smyth). The base map Smyth used is the map published with the journal in 1862.

The period of recession 1863-1870

By 1863 the Gregorys had moved to the eastern colonies of Australia. While several expeditions took place in the period 1863-1870 geological deductions based on specimens collected were invariably made by geologists residing outside the colony.

The journals of the expedition of H. M. Lefroy eastwards of Perth were regrettably never published in full; however, a typescript is held by the Western Australian Library Board. The journal reveals a careful observer of the granite terrains and salt flats he traversed which is not immediately apparent in the brief published abstract (Lefroy 1864). Lefroy considered that he was observing a mass of granite that was of the original formation of the globe and which had remained undisturbed for many years.

The Rev W. B. Clarke of Sydney had been sent various collections of rocks from Western Australia and wrote numerous articles. He commented (1864) on the possibility of gold being found in the colony and described the collection of granitic and hornblende rocks collected by Hunt in 1864 near Lake Lefroy (Clarke 1866a). A case of fossils from 24 km north of Champion Bay, sent to Clarke in 1863 by F. B. Barlee the Colonial Secretary was revealed by Clarke (1866b and 1868) to contain further evidence of the presence of Mesozoic rocks in the western portion of the continent. While Mesozoic fossils were sent to Clarke, H. M. Lefroy sent Quaternary fossils to the Rev. J. E. Tenison Woods, who used them (1868, p. 45) to question the extent of the Quaternary ice age in Australia.

A visitor to the colony, Edward H. Hargreaves (Hargreaves) after making several excursions decided that the possibility of gold occurring in the colony was nil (Hargreaves 1864). Blainey (1969, pp. 13-19) has created a colourful picture of this fat man who "found it exhausting to shovel gravel or work the cradle all day". If he found it a difficult task to ride a horse from Sydney to Bathurst it appears unlikely that his "various excursions into the interior" of Western Australia went far beyond the outposts of civilization. As A. R. C. Selwyn the Victorian Government Geologist, who was present at the meeting of the Royal Geographical Society in London when Hargreaves' paper was presented, observed "we ought hardly to take an examination of the coastline as a proof that the whole of Western Australia would not be auriferous because if we looked at the enormous expanse of Western Australia it would seem that Mr. Hargreaves had traversed it but to a very limited extent".

The mid 1860s saw the expeditions of James Martin and R. J. Sholl and although their Journals were published they contain only very occasional

references to geology. The 1866 route ascribed to Cowle (Dean 1872) appears to be that of a subsidiary expedition of the Sholl expedition, however, I am unaware of any published account.

The expedition of John Forrest, in search of the remains of Ludwig Leichhardt and party, in 1869 was the first of a series of expeditions ushering a new dawn of geological exploration in Western Australia. The exploration by the Forrests together with the investigations of the new Government Geologist, H. Y. L. Brown and the Work of Rev. C. G. Nicolay in Perth initiated the beginning of a new period of geological exploration in 1870 (Valance 1975, p. 35; Connolly 1976, p. 80-85).

Conclusion

The geological exploration of Western Australia prior to settlement and during the first forty years of the colony was often of secondary importance to those blown off course, seeking shelter or struggling to develop the colony. However, tangible observations and discoveries were made and they formed the basis of much of the later investigations for the rest of the nineteenth century. Although the contributions of these pioneers may now be outdated they represent an important facet of the early stages of development of the State that has just celebrated its sesquicentenary.

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